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30 MAY – 5 JUNE 2022

IMPROVING AIR QUALITY TOGETHER
LIFE IP PrepAIR:
project's achievements
and main results

31st May 2022
Emilia-Romagna Region
Delegation to the EU

NEXT GEN EU

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prepAIR Po Regions Engaged to Policies of Air

30 Life 1992 - 2022

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Po Regions Engaged to Policies of Air

The impact of reducing Ammonia and NOx on PM concentrations in Po Valley

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Working group

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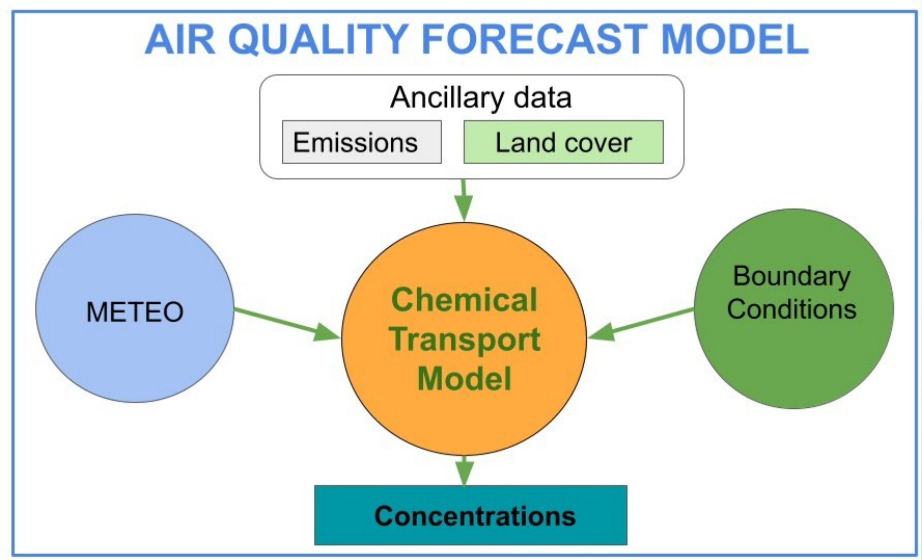
Methodology and aim of this work

Analyse NOx and NH3 chemical process and the sensitive of PM2.5 concentration to NH3 and NOx

Modellng study is perfomed with three CTM air quality models



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Models system description

	FARM-PI	FARM-LO	NINFA-ER
Doman (Po Valley)	585*430 km2	836 x 416 km2	585*430 km2
Resolution	5 km, 16 levels	4 km, 16 levels	5 km, 9 levels
Meteo model	COSMO I5	WRF	COSMO I5
Year	2019	2019	2019
BC/IC data	Prev'Air	Qualearia	Prev'Air
CTM	FARM	FARM	CHIMERE
Emissions	prepAIR 2017 (action D2)	prepAIR 2017 (action D2)	prepAIR 2017 (action D2)

Monthly observed (in blue) and modelled (in red) background PM 2.5 concentration

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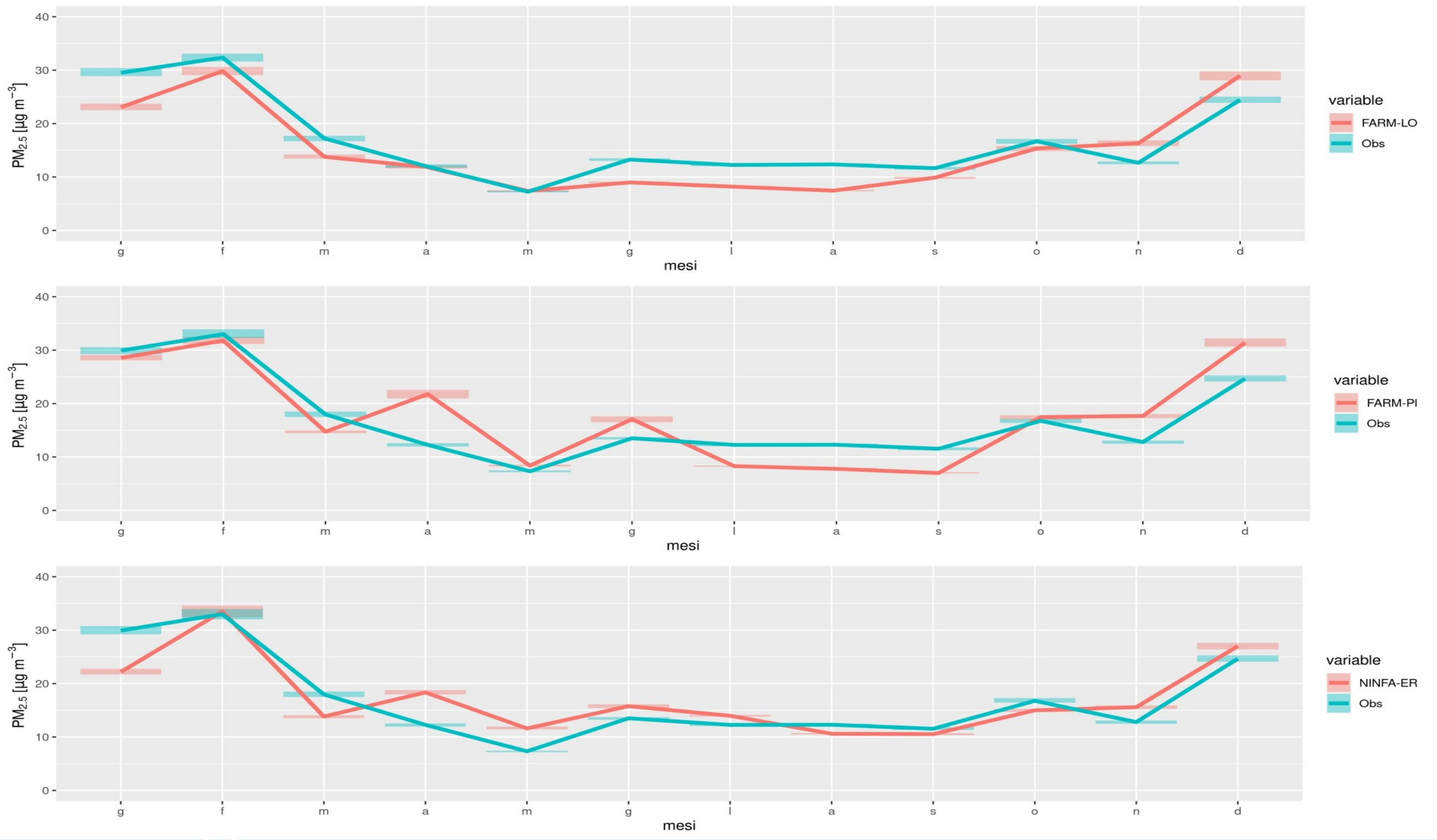

Good agreement between model simulations and monitoring data

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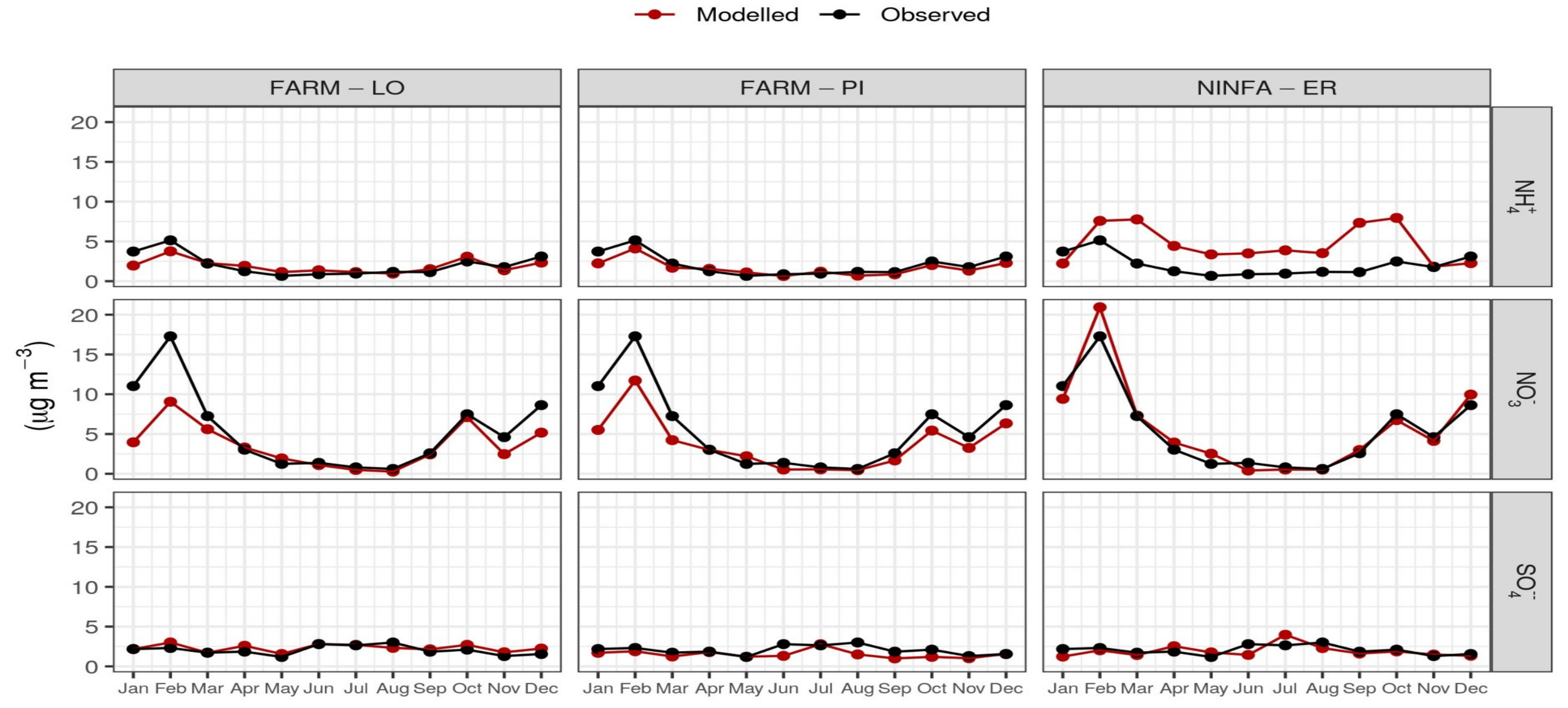
Monthly observed (in black) and modelled (in red) inorganic PM10 compounds



General good agreement with FARM-LO and FARM -PI NO3- overestimation in January and February, and NINFA-ER NH4+ overestimation

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Scenario simulations

Scenario	NOX (%) reduction	NH3 (%) reduction	notes
Sc1	0	0	***
Sc2	10	0	***
Sc3	0	10	***
Sc4	10	10	**
Sc5	25	0	***
Sc6	0	25	***
Sc7	25	25	***
Sc8	50	0	***
Sc9	0	50	***
Sc10	50	50	***
Sc11	75	0	***
Sc12	0	75	***

Scenario	NOX (%) reduction	NH3 (%) reduction	notes
Sc13	75	75	***
Sc14	10	25	**
Sc15	10	50	**
Sc16	10	75	**
Sc17	25	10	**
Sc18	25	50	**
Sc19	25	75	**
Sc20	50	10	**
Sc21	50	25	**
Sc22	50	75	**
Sc23	75	10	**
Sc24	75	25	**
Sc25	75	50	**

25 seasonal and annnual simulation with different NOx and NH3 emission reduction from 10% to 75%

*** FARM-LO, FARM-PI, NINFA-ER
** FARM-PI, NINFA-ER

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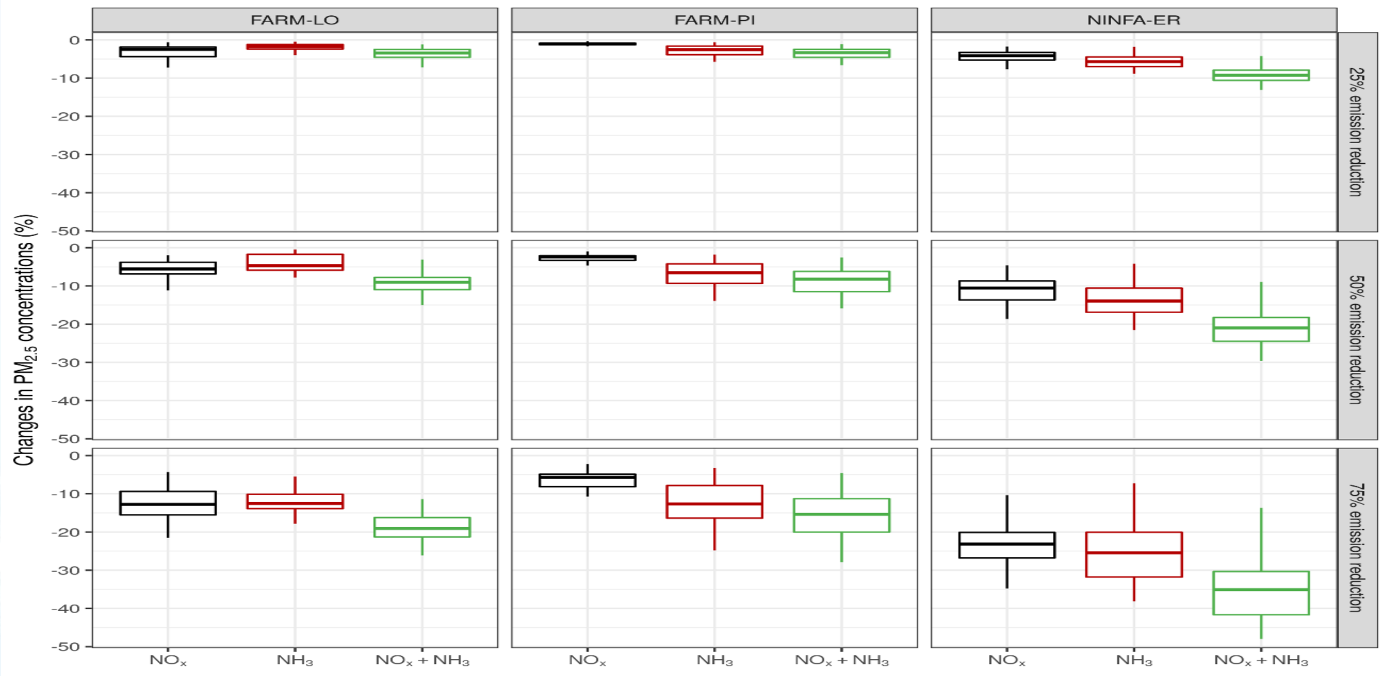
PM2.5 percentage reduction concentration (average january -march)



Reducing emissions of both precursors is more effective in terms of reducing concentrations than reducing only one of the precursors for all modeling systems, an advantage that increases as the magnitude of emission reduction increases.

PM2.5 percentage concentration reductions ensamble model (january-

Reduction	Emission	25° percentile	mean	median	75° percentile
25 %	NOx	1.7	3.4	2.7	4.7
25%	NH3	1.1	2.8	2.3	4.2
25%	**NOx+NH3**	**3.0**	**5.4**	**4.5**	**7.9**
50%	NOx	4.4	8.3	6.9	11.5
50%	NH3	3.1	6.5	5.5	9.5
50%	**NOx+NH3**	**7.8**	**13.0**	**10.9**	**18.2**
75%	NOx	10.9	17.0	14.5	21.9
75%	NH3	7.7	14.0	12.1	20.9
75%	**NOx+NH3**	**15.6**	**23.2**	**20.5**	**30.4**

Summary table of the distribution of the percental reduction of PM25 in the different emission scenarios considering the ensamble of the three modeling systems

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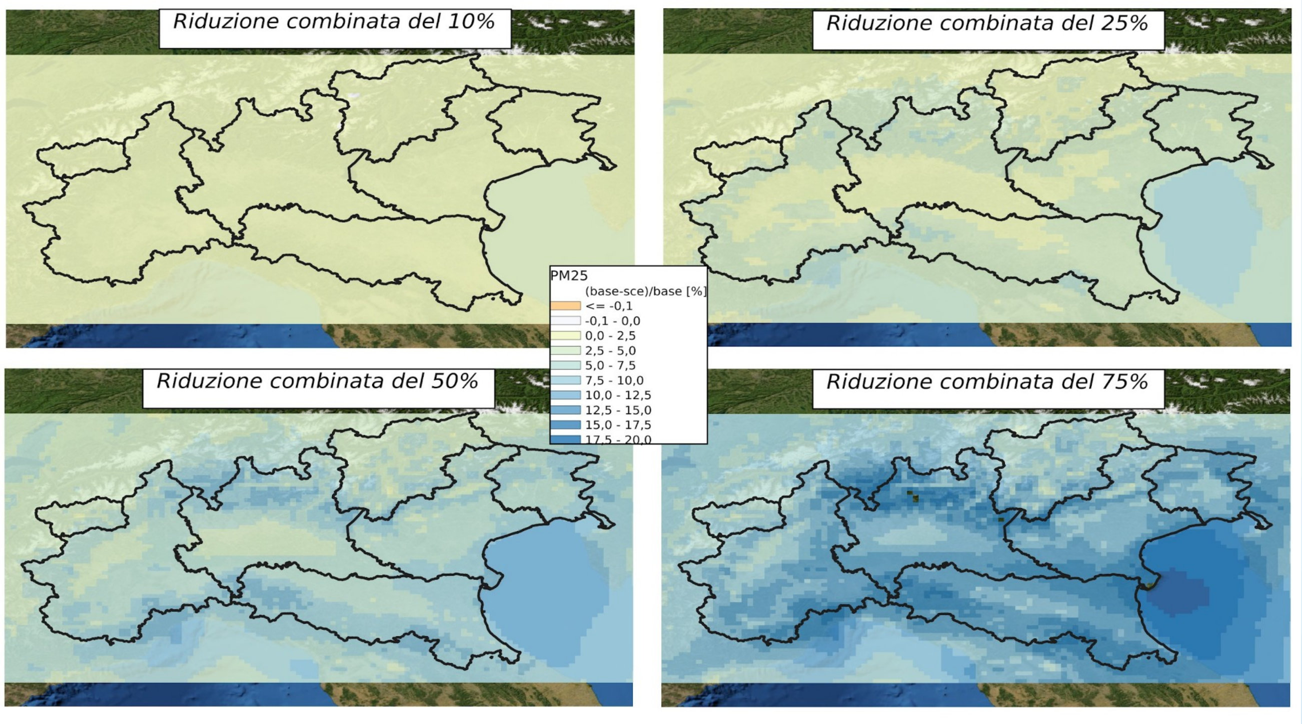
PM2.5 percentage concentration reduction ensamble model (average january-march)



Percentage PM2.5 emission reduction both NH3 e NOx

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Precursor potential impact

To analyze more precisely the importance and impact of different emission changes in NOx and NH3 on PM2.5 concentrations, indicators called **potential impact** were calculated, defined as the ratio of the change in concentrations to the change in emissions.

$$P\ (NOx)=\Delta C\ (NOx)/\Delta E$$
$$P\ (NH3)=\Delta C\ (NH3)/\Delta E$$

In this way, while it remains more efficient to reduce both precursors simultaneously, it is possible to identify any areas where, for the same NOx and NH3 emission reductions, more pronounced PM2.5 decreases are obtained.

We define the **chemical regime** as the difference between P(NOx) and P(NH3)

Positive chemical regime (*NOx more sensitive*): more efficient NOx emission reductions
Negative chemical regime (*NH3 more sensitive*): more efficient NH3 emission reductions

Chemical regimes of ensamble model (average january-

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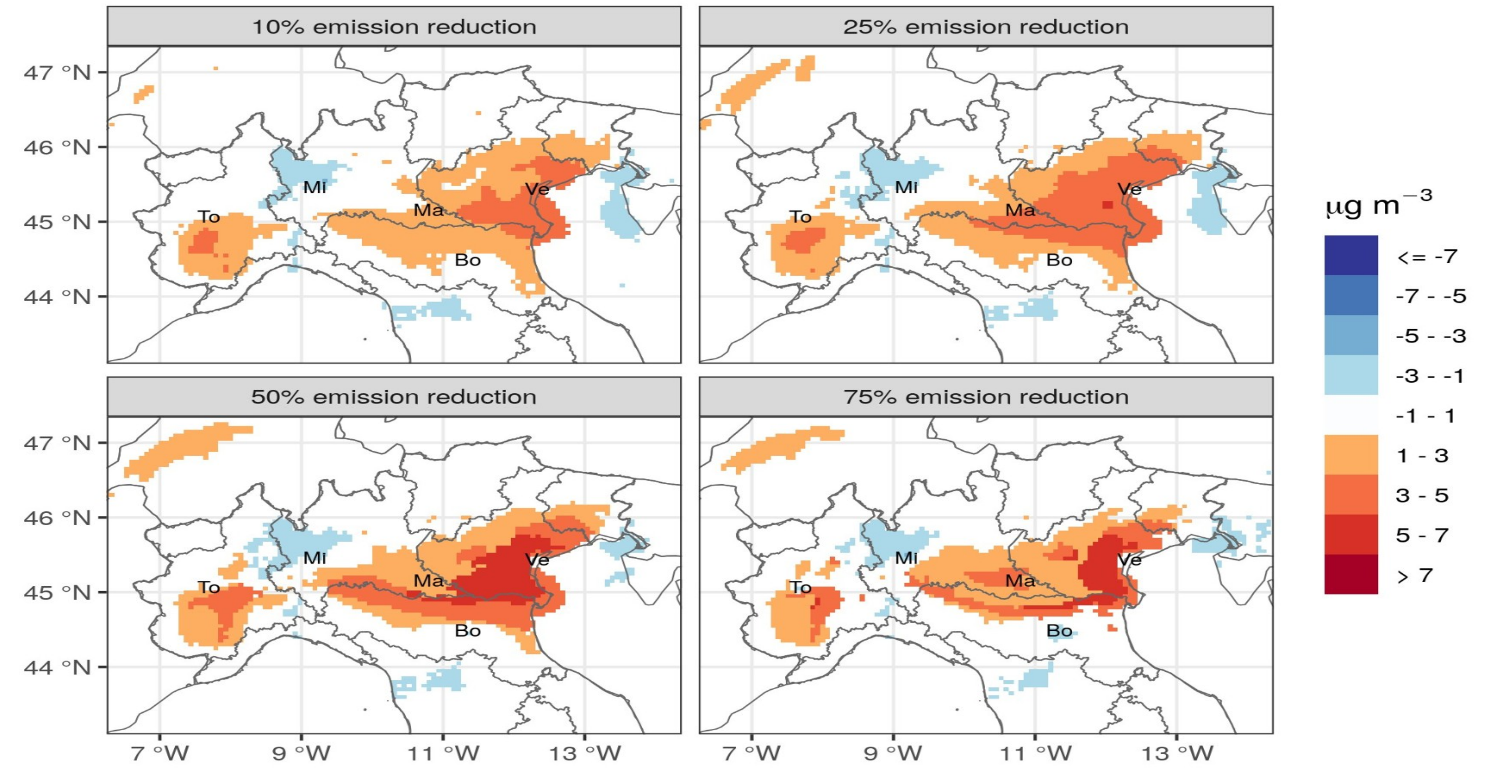

Blue areas indicate areas where it is most efficient to reduce NH3, orange areas where it is most efficient to reduce NOx, and white areas where NH3 and NOx reductions are equally efficient.

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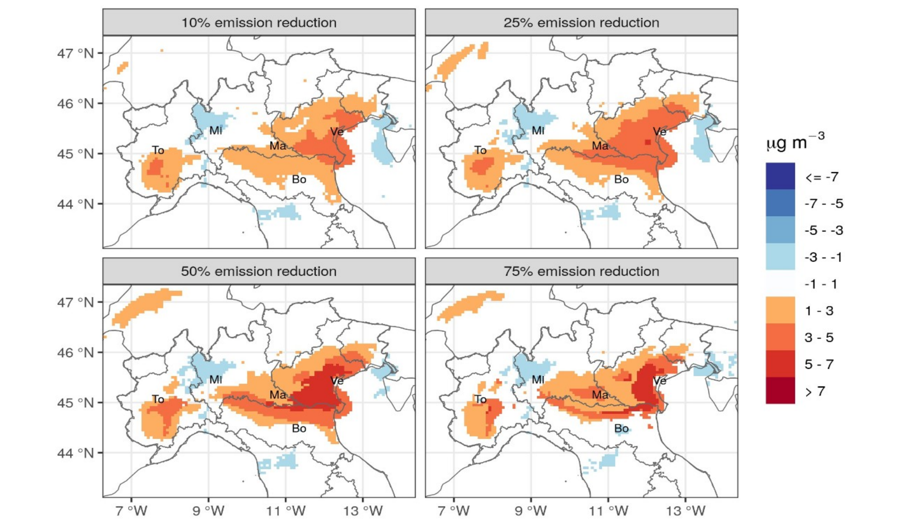
Chemical regimes january-march

modello	riduzione	NH3 more sensitive [%]	NOx+NH3 sensitive [%]	NOx more sensitive [%]
ENSEMBLE	10%	6,5	55,0	38,5
ENSEMBLE	25%	7,3	51,4	41,3
ENSEMBLE	50%	7,4	51,1	41,5
ENSEMBLE	75%	6,7	58,5	34,8

In most of the Po Valley, NOx and NH3 reductions have equal importance on PM2.5 concentration

In the Emilia-Lombardia plain, the Cuneo area, and the Veneto region, with equal reductions, those of NOx are more effective in reducing PM2.5 concentrations
In an area north of Milan, the situation is reversed



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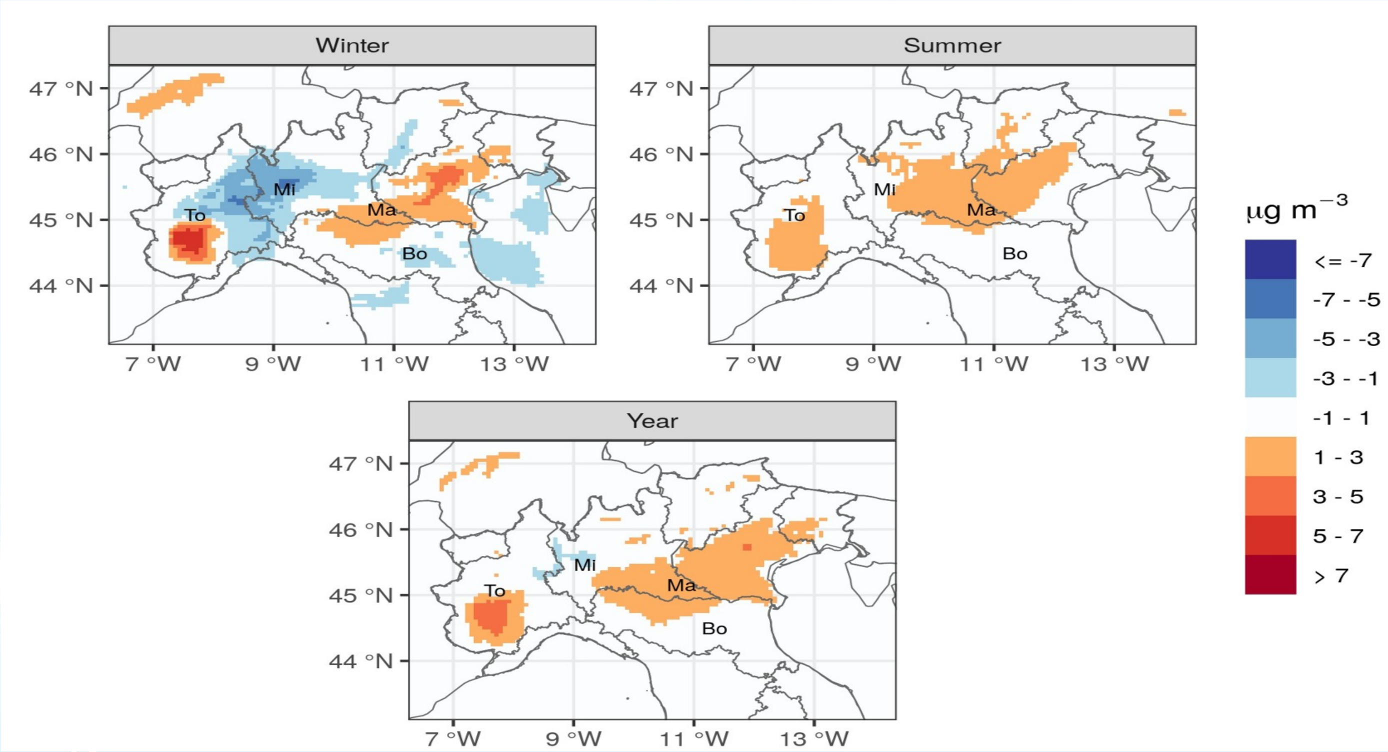
Seasonal chemical regimes
NINFA-ER with 25% emission reduction



In winter (November-February), two *more sensitive NOx* macro areas, one *more sensitive NH3* macro area, and two smaller *more sensitive NH3* areas are shown.
In summer (May-September) the *NOx more sensitive regime* prevails over the other

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Conclusions

- The study aims to provide insights to better understand the response of PM2.5 to changes in NOx and NH3 emissions

- The study is inspired by other similar recent studies in the literature (Thunis 2021, Clappier 2021).

- The use of three different modeling systems provides greater robustness to the results obtained, although these still need further investigation to be best interpreted.

- The results show that a combined reduction of the two precursors is definitely the most efficient in reducing PM2.5 concentrations.

- In the winter period (Nov-Feb), *NH3 more sensitive* areas include urban areas such as Milan, Bologna, Turin, and Venice.

- However, with the same precursor reduction, there are areas where acting on one precursor is more advantageous than acting on the other, and in this case the *NOx more sensitive* zones prevail.

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Many Thanks